भारतीय मानक
Indian Standard

IS 16231 (Part 1) : 2019

भवनों में काँच के प्रयोग — रीति संहिता

भाग 1 चयन के लिए सामान्य कार्यप्रणाली

(पहला पुनरीक्षण)

Use of Glass in Buildings — Code of Practice

Part 1 General Methodology for Selection

(First Revision)

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Building Construction Practices Sectional Committee, CED 13

FOREWORD

This Indian Standard (Part 1) (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Building Construction Practices Sectional Committee, had been approved by the Civil Engineering Division Council.

Glazing is an important item in building construction, and glass, the primary glazing element has to be selected to cater to several requirements. Fixing of glass is a specialized operation, when properly done, shall avoid the hazards of broken glass. Growing trend in resorting to glazed windows/doors in buildings; and structural glazing on exterior of buildings and structures has considerably increased the importance of glazing and the need for proper workmanship. This standard was, therefore formulated to provide required guidance and provisions on the subject matter.

This Indian Standard is published in four parts. The other parts in this series are:

Part 2	Energy and light
Part 3	Fire and loading
Part 4	Safety related to human impact

This standard (Part 1) was first published in 2016 to provide guidance in the selection of appropriate glazing for various types for building construction.

Correct selection of materials to be used in glazing for buildings depends on many factors. Therefore, provisions in this standard should be used in conjunction with those in other parts.

Use of organic coated films including safety films on glass (say annealed) shall not be construed as safety glass as per this standard, and hence users should exercise caution in choosing their options.

This revision of the standard is aimed at bringing the provisions at par with the provisions of the SP 7 (Part 6/Sec 8) : 2016 'National Building Code of India 2016: Part 6 Structural Design, Section 8 Glass and Glazing'.

In this revision, the following major changes have been made:

a) Reference to sustainability aspects during the selection of glass has been introduced;
b) Various possible laminated glass combinations have been included;
c) Provisions related to selection of materials for glass fins have been included;
d) Deflection limits for the frame and the centre of glass pane have been updated; and
e) Definitions of various terms have been updated as per the prevailing engineering practice.

With the publication of this standard (along with the other parts) it is proposed to withdraw the IS 3548 : 1988 'Code of practice for glazing in buildings (*first revision*)', in view of the comprehensive provisions proposed herein. However, the contents of the same are included in this standard as an informative annex (*see* Annex B).

The composition of the Committee responsible for the formulation of this standard is given in Annex C.

For the purpose of deciding whether a particular requirement of this standard is complied with the final value, observed or calculated, expressing the result of a test or analysis shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be same as that of the specified value in this standard.

Indian Standard

USE OF GLASS IN BUILDINGS — CODE OF PRACTICE

PART 1 GENERAL METHODOLOGY FOR SELECTION

(First Revision)

1 SCOPE

1.1 This standard (Part 1) covers the selection and application of glass in buildings, different types of glass and their requirements, and associated glazing materials.

1.2 This standard does not cover the following:

a) Glazing systems including frameless glazing system, and
b) Patent glazing.

NOTE — The provisions of this standard pertain to selection of glass and associated materials. However, parties, as per their mutual agreement, may appropriately utilize the relevant provisions for installation of alternative sheeting materials used for similar purposes such as plastic glazing sheets/polycarbonate sheets taking also into account requirements of safety issues as applicable with the specific material.

2 REFERENCES

The standards listed in Annex A contain provisions which, through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subjected to revision, and parties to agreement based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated in Annex A.

3 APPLICATION

While selecting the glass for application, the type of glass shall satisfy the following criteria:

a) Glazing thickness calculation subjected to wind load is calculated in accordance to IS 16231 (Part 3) and shall satisfy the requirements for human impact safety as per IS 16231 (Part 4).
b) Installation of glass to the building is done in accordance with the provisions available in this standard and in the absence of any specific provisions, shall be as per manufacturer's guidance.
c) For a given application, the type and thickness of glass selected shall be in accordance with the requirements provided herein.
d) Optical, solar, thermal performance of glazing (clear/tinted/coated reflective glass) shall be as per the requirements in IS 16231 (Part 2) or as per the provisions hereunder.

4 TERMINOLOGY

For the purpose of this standard, the definitions given in IS 14900, IS 2553 (Part 1) and the following shall apply.

4.1 Annealed Glass (*see* **4.18**) — Also known as 'normal' glass, which has not been subjected to toughening, lamination and heat strengthening. It is the product obtained from the process of slow and steady cooling of hot glass in order to relieve internal stresses or thermal induced stresses.

NOTE — This term is most commonly used for flat glass.

4.2 As-cut Finished Sizes — Finished panes of flat glass cut from stock/standard sizes. They may be subjected to further processing, such as edge working drilling, face decoration, etc.

4.3 Aspect Ratio — The ratio of a longer side of glass pane to its shorter side.

4.4 Beads or Glazing Beads — A strip of wood, metal, UPVC, aluminium, metal alloys or other suitable material attached to the rebate to retain the glass in position in the frame.

4.5 Block (Setting Block) — A small piece of wood, plastic, rubber or other suitable material used between the edges of the glass (generally the bottom edge only) to centralize the glass in the frame (frequently called a setting block).

4.6 Clear Glass — A transparent glass with neutral/near colourless appearance.

4.7 Coating Faults — It is the fault on reflective silver layer which shall alter the appearance of the silvered glass. They consist of scratches, stains, colour spots and edge deteriorations.

4.8 Coefficient of Linear Expansion — It is expressed as the strain (change in length per unit length) per unit variation of temperature of a material.

4.9 Distance Piece — A small piece of wood or other suitable material used to locate the glass between the bead and the back of the rebate to prevent lateral movement.

4.10 Double Glazing — Glazing formed by an assembly of two glass panes separated by a spacer and the gap may be filled by air or inert gases and hermetically sealed along the periphery to improve thermal insulation.

4.11 Faceted Glazing — It is a type of glazing in which flat panes of glass are installed vertically at an angle to each other to form a faceted surface.

NOTE — While no frames are used normally, in special cases, frames may also be used to achieve/maintain the curve.

4.12 Fenestration — All area (including frame) in the building envelope that let in light, including window, plastic panels, clerestories, skylight, glass doors that are more than one-half the floor height, and glass block walls.

4.13 Float Glass — Flat, transparent, clear or tinted soda-lime silicate glass having parallel and polished surfaces obtained by casting and floatation on a metal bath.

NOTE — Flat glass is a general term covering sheet glass, float glass and various forms of rolled and plate glass in which shape of the glass is flat and commonly used for windows, glass doors, transparent walls and other architectural applications.

4.14 Frame — An element made of timber/metal/aluminum or other durable material/combination of materials such as glass fins and structural sealant, supporting the full length of a glazed panel edge.

4.15 Frameless Glazing — An unframed glazing which maintains the integrity through pointed support structures.

4.16 Front Putty — The compound forming a triangular fillet between the surface of glass and the front edge of rebate.

4.17 Fully Framed Glazing — The glazing whose panels have all its four edges framed.

4.18 Glass — An inorganic, non-metallic material produced by the complete fusion of raw materials at high temperatures, into a homogenous liquid which is then cooled to a rigid condition without crystallizing. It is typically hard and brittle, and has a conchoidal fracture. It may be colourless or tinted and transparent to opaque. The term glass refers to monolithic glass unless specified otherwise.

4.19 Glazing — Act of securing of glass or plastic glazing sheet material into a building in prepared openings in windows, door panels, partitions, curtain wall, etc.

4.20 Heat Strengthened Glass — Glass within which a permanent surface compressive stress, has been induced by a controlled heating and cooling process in order to give it increased resistance to mechanical and thermal stress and prescribed fracture characteristics.

4.21 Hermetic Seal — A complete seal (especially against the escape or entry of air which is impervious to outside interference or influence) done on insulating glass units.

4.22 Infill Balustrades — The balustrades in which the supported glass resists an infill pressure and/or point load applied to the glass panel.

4.23 Insulating Glass Unit (IGU) — An assembly consisting of at least two panes of glass, separated by one or more spaces, hermetically sealed along the periphery, mechanically stable and durable.

4.24 Interlayer — Layer or material acting as an adhesive and separator between plies of glass and/or plastic glazing sheets.

NOTE — It can be designed to give additional performance to the finished product, for example impact resistance, fire resistance, solar control and acoustic insulation.

4.25 Laminated Safety Glass — It is a glass made of two or more pieces of glass which are held together by an interleaving layer or layers of plastic materials.

4.26 Maximum Thickness — The thickness of a pane of glass at the maximum thickness tolerance.

4.27 Minimum Thickness — The thickness of a pane of glass at the minimum thickness tolerance.

4.28 Modulus of Elasticity (Young's Modulus) — This modulus expresses the tensile force that would theoretically have to be applied to a glass sample to stretch it by an amount equal to its original length. It is expressed as a force per unit area (for glass, $E = 0.7 \times 10^5$ N/mm^2 = 70 GPa).

4.29 Monolithic Glass — A single sheet of flat glass which could be either annealed, toughened or heat strengthened.

4.30 Mullion — Vertical framing member separating and supporting two adjacent panes of glass or panels.

4.31 Nominal Thickness — A numeric designation that indicates the approximate thickness of glass.

4.32 Organic Coated Glass — A sheet of glass coated on one or both sides with an applied organic coating or sheeting.

4.33 Pane — A single piece of glass or plastic glazing sheet material in a finished size ready for glazing.

4.34 Patterned Glass — A rolled glass having a distinct pattern on one or both surfaces.

4.35 Rebate — The part of a surround; the cross-section of which forms an angle into which the edge of the glass is received.

4.36 Reflective Coated Glass — It is a glass with reflective coating which uses the principle of increasing the direct reflection to maximize solar energy attenuation. In comparison with clear glass, its absorption of solar energy is also increased.

NOTE — In comparison with float glass surface, these reflecting coatings (due to their composition) exhibit lower level of emissivity which improves their *U*-value.

4.37 Sheet Glass — Glass made in large sheet directly from furnace or by making a cylinder and then flattening it.

NOTE — These transparent glass have a glossy, fire-finished, apparently plane and smooth surfaces, but having a characteristic waviness of surface.

4.38 Skylight — A fenestration surface having a slope of less than 60° from the horizontal plane. Other fenestration, even if mounted on roof of a building is considered as either a vertical glazing or sloped glazing depending upon the angle of the glazing.

4.39 Stock/Standard Sizes — The panes of flat glass such as coated, mirror, enameled glass, etc, supplied with as-cut edges which are intended for further processing. These are generally corresponded with manufacturer's production size.

4.40 Thermal Transmittance (*U*) — Thermal transmission through unit area of the given building unit divided by the temperature difference between the air or other fluid on either side of the building unit in steady state conditions. It is also called as *U*-value. Its unit is W/m^{2}K.

NOTES

1 Thermal transmittance differs from thermal conductance in so far as temperatures are measured on the two surfaces of a building unit in the latter case and in the surrounding air (or other fluid) of the material on the two sides, in the former case. Thermal conductance is a characteristic of the building unit whereas thermal transmittance depends on conductance and surface coefficients of the building unit under the conditions of use.

2 In the case of a glazing system, thermal transmission is taken through the central part of the glass, and thermal conductance of the frame needs to be considered to determine the overall thermal transmission through the glazing system.

4.41 Through Component/Connection — The internal spacer or fixing that either penetrates through the door-set or openable window from one face to another or directly connects the faces of one to the other.

4.42 Tinted Glass — A normal flat glass to which colourants (normally metal oxides) are added during manufacturing process to achieve tinting and solar radiation absorption properties. It is also referred to as body tinted glass.

4.43 Toughened (Tempered) Glass — A single piece of specially heat-treated glass, with a stress pattern such that the piece when fractured reduces to numerous granular fragments, with no large jagged edges.

4.44 Transom — A horizontal cross bar connecting two vertical members in a glazing frame.

4.45 Unframed Glazing — A glazing with one or more edges unframed.

4.46 Vertical Fenestration — All fenestration other than skylights. Trombe wall assemblies, where glazing is installed within 300 mm of a mass wall are considered walls and not fenestration.

5 SELECTION

5.1 Right from the initial project evaluation stage, a suitable methodology that incorporates the implications of use of glass materials and their influence on performance of the building shall have to be looked into. A typical flowchart outlining such a methodology is provided for the users of this standard (*see* Fig. 1).

It is assumed that,

a) the location of area to be glazed, preliminary size/shape have been decided as part of normal building design process;
b) the designer has gained information on glass/and plastic glazing sheet materials used in similar circumstances; and
c) the designer is cognizant of implications of any innovation in design.

5.2 Design requirement including aesthetic, functional and safety considerations; and client specified requirements such as security and maintenance needs to be considered.

5.3 Effect of design on cost such as initial cost of glazing (specification of glass/plastic sheeting material; glazing method; access for initial glazing; work schedule; protection during construction); effect of glass/plastic sheeting material on capital/running cost related to building heating/cooling, lighting and ventilation; and maintenance cost of glazed areas (access for cleaning and reglazing) should be considered.

5.4 Selection of appropriate glass may be done considering the cost benefit analysis in respect of the benefit accrued against the alternatives available. Also, the comparative cost of glazing materials should be considered together with their life expectancy and probability of need for maintenance. In the context of selection of glass, the provisions given in SP 7 (Part 11) : 2016 'National Building Code of India 2016: Part 11 Approach to Sustainability' may also be considered in addition to the cost benefit analysis on the use of glass *vis-à-vis* use of other alternatives. To suitably modify

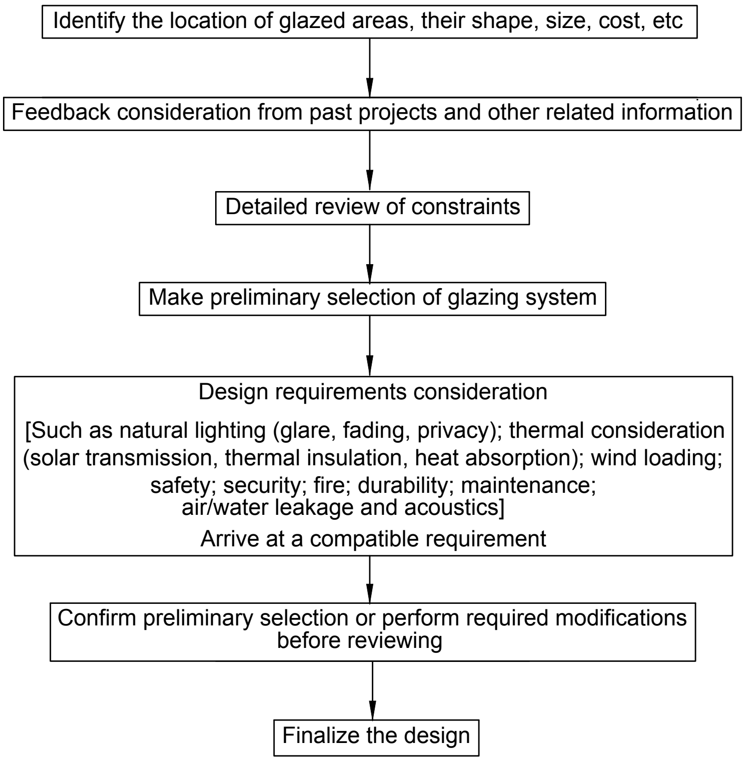

Identify the location of glazed areas, their shape, size, cost, etc
Feedback consideration from past projects and other related information
Detailed review of constraints
Make preliminary selection of glazing system
Design requirements consideration
[Such as natural lighting (glare, fading, privacy); thermal consideration (solar transmission, thermal insulation, heat absorption); wind loading; safety; security; fire; durability; maintenance; air/water leakage and acoustics]
Arrive at a compatible requirement
Confirm preliminary selection or perform required modifications before reviewing
Finalize the design

FIG. 1 TYPICAL SEQUENCE OF DESIGN EVALUATION FOR GLAZED AREAS

Table 1 Typical Properties of Various Types of Glass

(*Clause* 6.1)

Sl No.	Properties	Sheet Glass	Float Glass	Laminated Glass	Tempered or Toughened Glass	Heat Strengthened Glass
(1)	(2)	(3)	(4)	(5)	(6)	(7)
i)	Tensile strength	40 N/mm^2	40 N/mm^2	40 N/mm^2	120 to 200 N/mm^2	40 to 55 N/mm^2
ii)	Thickness	As per IS 2835	As per IS 14900	3.5 – 19 mm	2 – 19 mm	As per IS 16982
iii)	Density (approximate)	← 2 400 – 2 550 kg/m^3 →				
iv)	Modulus of elasticity	← 70 GPa →				
v)	Coefficient of linear expansion	← 9 x 10^{-6} m/m K →				
vi)	Compressive strength	← 1 000 N/mm^2 →				

NOTE — Conventionally, the following types of glass exist:

a) Annealed (clear) glass.

b) Extra clear glass.

c) Body tinted glass.

d) Coated glass (including Lacquered glass), namely:
  1) Online coated glass.
  2) Offline coated glass.

e) *Processed glass* — Each of the glasses (a) to (e) can be subjected to further processing to produce the following types:
  1) Heat strengthened,
  2) Toughened or tempered,
  3) Double glazed unit,
  4) Laminated glass (Single laminated),
  5) Laminated double glass unit,
  6) Ceramic/screen printed fritted glass (patterned glass), and
  7) Fire safety glass.

to indicate that the selection of appropriate glass may be made considering the cost benefit analysis in respect of the benefit accrued against the alternatives available.

6 TYPES OF GLASS

6.1 The soda lime silicate glass is classified based on the type of internal stress which determines the strength of the glazing towards breakage, design and installation procedure and based on application. Table 1 gives the typical properties of various types of glass.

6.2 Normal (Annealed) Glass

6.2.1 For requirements including tests on nominal thickness of annealed (flat) glass (*see* Table 1 of IS 2835). Flat transparent sheet glass shall conform to the following classes as specified in IS 2835 namely:

a) A quality or Selected Quality (SQ),
b) B quality or Ordinary Quality (OQ), and
c) C quality or Greenhouse Quality (GQ).

Transparent float glass shall be as per IS 14900.

A transparent flat glass is designated as clear glass when it is not tinted and when its light transmittance after any necessary pre-treatments is greater than the value prescribed in Table 2 for the nominal thickness.

NOTE — Group C class is not suited for architectural purposes.

6.3 Laminated Glass

6.3.1 Laminated glass is a glass configuration made of two or more pieces of glass bonded together by interlayer/interlayers. It is commonly used as a form of safety glass which cracks and breaks under sufficient impact, the broken glass fragments being still held together. When laminated glass is broken, fragments tend to adhere to the interlayer. For requirements of laminated safety glass, IS 2553 (Part 1) may be referred.

6.3.2 Laminated glass does not shatter like ordinary glass. It absorbs impact, resists penetration, and remains intact even if broken, holding glass fragments in place and lowering the risk of injury. Laminated glass is capable to stop flying debris and limit or avoid splintering on opposite side of the impact. When exposed to heat from solar radiation resulting in unequal temperature in the pane, laminated glass breaks but stays in place longer. The risk of thermal breakage is avoided only when heat strengthened/tempered laminated glass is used.

6.3.3 Laminated glass can be made from the following typical combinations:

a) Glass which is float/sheet/patterned/polished wired/wired patterned glass, and may be having the following properties:
    1) Clear, tinted or coated;
    2) Transparent, translucent or opaque;
    3) Annealed, heat strengthened or toughened; and
    4) Surface treated (such as acid etched or by sandblast).
b) Plastic glazing sheet material which can be polycarbonate or acrylic and may be having the following properties:
    1) Clear, tinted or coated; and
    2) Transparent or translucent.
c) Interlayers which differ based on material type and composition; mechanical characteristics; and optical characteristics, and may be having the following properties:
    1) Clear or coloured;
    2) Transparent, translucent or opaque; and
    3) Coated.

NOTE — Until standards on plastic glazing sheet materials and interlayers are formulated, they will be subject to the specifications of manufacturers of laminated glazing materials.

6.4 Toughened or Tempered Glass

6.4.1 Toughened glass is a type of safety glass which is heat treated to a uniform temperature of approximately 650°C and rapidly cooled to induce compressive stresses of 75.5 MPa (770 kg/cm^2) to 143.4 MPa (1 462 kg/cm^2) on the surfaces and edge compression of the order of 66.7 MPa (680 kg/cm^2). For requirements of toughened safety glass, IS 2553 (Part 1) may be referred.

6.4.2 Toughened glass gains its added strength from the compressed surfaces. However, if a deep scratch or an impact penetrates the surface, the glass shall break into a number of small particles. Any attempt to cut, drill, grind or sand blast the glass after toughening may result in glass breakage. The heat treatment process does not change the light transmission and solar radiant heat properties of the glass.

Table 2 Minimum Light Transmittance Value Designating a Transparent Glass as Clear Glass

(*Clause* 6.2.1)

Nominal Thickness, mm	2	3	4	5	6	8	10	12	15	19	25
Minimum Value of Light Transmittance, percent	89	88	87	86	85	83	81	79	76	72	67

6.4.3 Toughened glass provides greater thermal strength. It increases resistance to both sudden temperature changes and temperature differentials up to 250°C compared with normal glass, which can withstand temperature differentials up to 40°C only. Thermally toughened glass is approximately four times stronger than annealed glass of the same thickness and configuration, and must comply with the requirements of IS 2553 (Part 1). Toughened glass is difficult to break and when broken, it shall break into many relatively small fragments, which are less likely to cause serious injury to people, as there are no jagged edges or sharp corners like in normal glass. On the contrary, the toughened glass is also susceptible to breakage when hit with a small tap at its edge using a hammer or a hard object. Toughened glass passing the requirements of IS 2553 (Part 1) only qualifies as safety glass. Toughened glass cannot be subjected to further processing, such as cutting, drilling, edge grinding after toughening and any alterations such as sandblasting or acid etching will weaken glass and can cause premature failure (*see* Notes).

Float glass contains some level of imperfection. One type of imperfection is nickel sulphide (NiS) inclusions. Most NiS inclusions are stable and cause no problems. There is, however, the potential for NiS inclusions that may cause spontaneous breakage in fully tempered glass without any load or thermal stress being applied. Heat soak testing is a process that exposes critical NiS inclusions in fully tempered glass. The process involves placing the tempered glass inside a chamber and raising the temperature to approximately 290°C to accelerate nickel sulphide expansion. This causes glass containing nickel sulphide inclusions to break in the heat soak chamber, thus reducing the risk of potential field breakage. However, the heat soak process is not 100 percent effective.

NOTES

1 The process of toughening is used to increase the strength of glass and to produce fracture characteristics that are desirable in many situations. However, the process of toughening can also lead to an increased risk of spontaneous glass fracture (associated with material impurities). Accordingly, the possibility of spontaneous fracture should be taken into account when toughened glass is used.

2 Heat soaking may minimize the risk of nickel-sulphide induced spontaneous fracture in toughened glass. Glass manufacturers may be consulted for advice relating to anticipated nickel sulphide minimization.

6.5 Heat Strengthened Glass

Heat strengthened glass is a type of tempered glass which has been strengthened thermally by inducing a surface compression of about 44.3 to 64.5 MPa (422 to 658 kg/cm^2) as compared to a range of 75.5 to 143.4 MPa (770 to 1 462 kg/cm^2) in case of fully tempered glass. Heat strengthened glass is valued for its mechanical strength, which is twice that of normal annealed glass though half of toughened glass. With the exception of strength and thermal resistance characteristics, heat strengthened glass retains the normal properties of annealed glass. Heat strengthened glass provides necessary resistance to thermal stress associated with high performance glazing materials such as tinted glass and reflective glass. It also provides necessary resistance to heat building up when used as spandrel glass. Heat strengthened glass with its flatter surface also results in the facade having less optical distortions. Heat-strengthened glass shall have a surface compression of 31 to 52 MPa.

NOTES

1 Heat strengthening associated with relatively less residual stresses < 52.0 MPa has lower risk of spontaneous glass fracture (associated with material impurities).

2 Surface compression (including fragmentation) four point bending, flatness tests are typically carried out to determine the characteristics of heat strengthened glass.

6.6 Reflective Glass

A metallic coating is applied to one side of the glass in order to significantly increase the amount of reflection by the glass of both the visible and infrared (light and heat) range of the electromagnetic spectrum. This metallic coating can be applied to clear or body tinted glass, without adversely affecting the transparency of the glass. The reflective glass imparts an enhanced appearance to the exterior of buildings due to the coating of metal oxides on the glass, they are widely applied as an aesthetic and energy efficient product in buildings for its highly reflective surface and its wide palette of colours. It reduces heat gain and glare from the exterior and allows optimum visible light transmission to the interior. If designed/used properly reflective glass can aid in reducing the air-conditioning load of the buildings.

NOTE — Highly reflective glass should be avoided, especially in internal environments. The reflections from these surfaces can be particularly confusing for persons with vision impairment.

6.7 Insulating Glass Unit

Insulating glass unit is a prefabricated unit of glass having an edge seal that not only binds the individual sheets of glass together to maintain the mechanical strength of the joint but also protects the cavity between the glasses from outside influences. The moisture in the cavity between the two glasses is controlled by desiccants filled in the perforated spacer. The spacer can be aluminum, composites, plastics, etc. The spacer ensures the precise distance between the glass panes. The cavity may be filled with inert gases (such as argon, krypton) for better thermal performance or it shall be ensured that air in between is dry. The low heat conductivity of the enclosed dry gas between the glass panes drastically reduces the thermal heat transmission through the glass to 2.8 W/m^{2}K (12 mm spacer between two, 6 mm glass) as compared to 5.73 W/m^{2}K for normal 6 mm glass. It also helps in reducing the direct solar energy specifically when the outer pane is a solar control glass. For sizes greater than 3 m^2, the thickness of the spacer shall be chosen such that physical contact of glass panes (white spots) does not occur.

NOTE — Moisture penetration test and inert gas level test; climate test are typically carried out to determine the characteristic; and structural integrity/performance respectively of IGUs.

6.8 Wired Glass

The general requirements including thickness, dimensional tolerance and tests for wired glass as specified in IS 5437 are valid.

NOTE — The size of panes using wired glass shall be limited to 0.84 m^2. Further, the use of wired glass shall be restricted in vertical applications only and not to be used in horizontal or inclined position.

6.9 Glass Fins

When glass fins are used as a decorative member, it can be either toughened (tempered) or laminated glass.

When glass fins are used as a structural member, it shall be heat strengthened/ toughened and laminated. The depth and thickness may vary as per elevation and wind load requirements. Design should also accommodate movements. It is recommended to use finite element analysis to determine the appropriate glass fin sizes.

NOTE — Annealed glass shall never be laminated and used as a fin as the same never provides the required safety.

7 APPLICATIONS

Glass can be designed/suited to use in building occupancies such as in residential, assembly and mercantile in elements such as façades, windows, doors, partitions, display units, shop fronts, greenhouses (where plants are grown), atrium. Different types of glass are selected based on requirements. For safety against accidental breakage due to impact and strength requirement (mechanical and thermal), toughened safety glass or laminated safety glass, as deemed fit shall be considered (*see* Note). For increased high security requirements, acoustic insulation, sloped glazing and skylights, laminated glass may be considered.

NOTE — Broken annealed glass falling on people can cause grievous or even fatal injuries; hence it is recommended to use safety glass in locations other than defined in Case 1 of IS 16231 (Part 4) where the risk of people getting hurt by falling glass is high.

8 ASSOCIATED GLAZING MATERIALS

8.1 Structural Sealant

The structural sealant could be of silicone type with requirements meeting the design criteria. Structural sealant shall be shelf-stable, natural-cured, elastomeric adhesive exhibiting the desired adhesion to building substrates. The structural sealant may require cleaning and/or priming to get good adhesion for structural glazing application. For laminated glass applications where glass edges are sealed with a sealant, compatibility shall be ensured with the interlayer to avoid delamination.

8.2 Gaskets

Gasket is a mechanical seal that fills the space between two mating surfaces, to prevent leakage from or into the joined objects and will be able to deform while under compression and tightly fills the space it is designed for, including any slight irregularities.

8.3 Preformed Tape

Typical requirement of preformed butyl and foam tapes shall be as given in Table 3.

Table 3 Typical Properties of Preformed Tapes

(*Clause* 8.3)

Sl No. (1)	Properties (2)	Requirements (3)
i)	Low temperature flex	No cracks at –23°C
ii)	Weight loss	2 percent, *Max*
iii)	Vehicle migration	1 paper stained maximum and this stain can be no more than 3.2 mm from edge of sample maximum
iv)	Backing removal	No transfer of tape compound to the paper
v)	Yield strength	41.4 kPa, *Min*
vi)	Compression/ Recovery	Compression index, 122 N/cm^2, *Max*
vii)	Water absorption	Weight gain maximum after boiling, 40 kg/m^3, *Max*
viii)	Flow test	Loss of height, 60 percent, *Max*

8.4 Setting Blocks, Location Blocks and Distance Pieces

Setting blocks, location blocks, and distance pieces shall be designed in accordance with IS 16231 (Part 3) which are,

a) resilient, load-bearing, non-absorbent and rot-proof materials; and
b) compatible with all other materials that may come in contact with them.

9 GENERAL REQUIREMENTS OF GLAZING

9.1 Glazing and associated materials used for the proper installation shall satisfy the minimum dimensional and framing requirements in accordance with the procedures given in this standard. The dimensional and thickness tolerance of the glass used in exterior and interior is determined from the provisions given hereunder.

9.2 Dimensional Requirement

9.2.1 The dimensions for edge clearance, edge cover, and front and back clearance, as defined in Fig. 2, shall be not less than the values given in Table 4.

NOTE — For glazing systems where the framing member is aluminium or steel, and gaskets are used to capture the glazing, minimum glazing bite of 12.7 mm is recommended for architectural glazing.

9.2.2 *Front Putty Width*

The front putty width shall be not less than 10 mm for panels up to 1 m^2, and not less than 12 mm for panels between 1 m^2 and 2 m^2.

9.2.3 *Dimensions of Rebates and Grooves (Width and Depth)*

Dimensions of rebates and grooves shall accommodate the requirement of Table 4 and allow for the appropriate setting and location blocks as in Fig. 1 to Fig. 3 of IS 16231 (Part 3).

9.2.4 *Glass Dimensional Tolerance*

The tolerance for dimensions shall be as per the respective Indian Standards given in Annex A.

10 FRAME REQUIREMENTS

10.1 When completely assembled and glazed, the secondary design action effects due to deflection of the frame member supporting the edge of the glass shall be allowed for.

10.2 Deflection Limits

The frame deflection limits under serviceability loading shall satisfy the conditions for four sided frames as given in **7.6.2** (c) of IS 16231 (Part 3).

NOTE — In framing members, where reinforcement/fixing brackets are required to meet the deflection/stress criteria, it may be of aluminium or steel. When steel is used, proper dielectric galvanic separation shall be used. The material chosen for reinforcement shall be in close proximity in the galvanic series, to ensure dielectric separation.

10.3 Panels Glazed into the Building Structure

A panel glazed directly into a building structure by means of appropriate beads or stops shall be considered

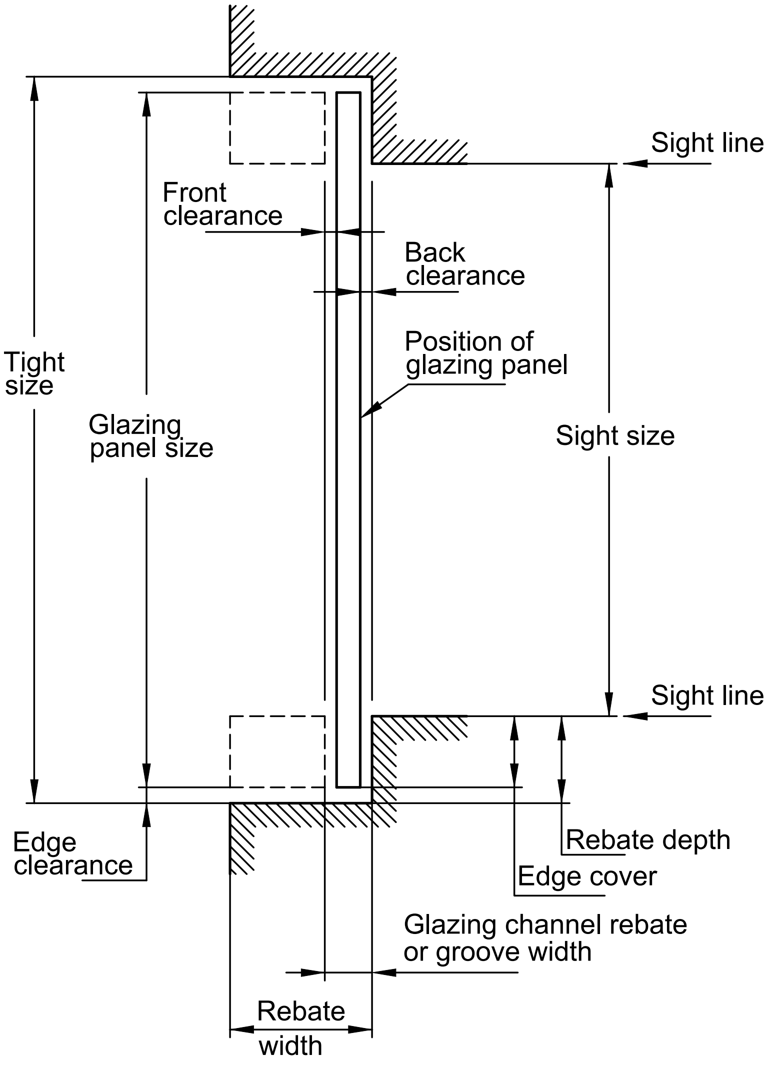


FIG. 2 SIZES AND REBATES

Table 4 Minimum Dimensions for Glazing Material

(*Clause* 9.2.1)

All dimensions in millimetres.

Sl No.	Nominal Thickness	Front and Back Clearance			Edge Clearance	Edge Cover	Rebate Depth
		(A) (*see* Note 1)	(B) (*see* Note 2)	(C) (*see* Note 3)			
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
i)	3 mm (pane area up to 0.1 m^2)	2	—	—	2	4	6
ii)	For pane area > 0.1 m^2	2	—	—	3	6	9
iii)	3	—	2	1	3	6	9
iv)	4	2	—	—	2	6	8
v)	4	—	2	1	3	6	9
vi)	5	2	2	2	4	6	10
vii)	6	2	2	2	4	6	10
viii)	8	—	3	2	5	8	13
ix)	10	—	3	2	5	8	13
x)	12	—	3	2	6	9	15
xi)	15	—	5	4	8	10	18
xii)	19	—	5	4	10	12	22
xiii)	25	—	5	4	10	15	15

NOTES

1 Type A applies to linseed oil and metal casement putties.

2 Type B applies to non-setting glazing compounds, plastic glazing compounds, two-part rubberizing compounds, sealants and preformed strip materials.

3 Type C applies to gaskets made from extruded materials such as butyl strip, PVC, neoprene and sanoprene held in position by pressure upon the glass.

4 For non-standard glass thicknesses the nearest values of nominal thickness, shall be used.

5 Timber and PVC frames may not require the specified front and back clearances provided the waterproofing performance requirements are met.

6 The dimensions are the minimum necessary for structural integrity of glass only but do not apply to insulating glass units.

to be framed, provided the assembly complies with the deflection requirements of **10.2**.

10.4 Mixed Framing

Glass supported along the top and bottom edges by one means and along the vertical edges by another means shall be considered to be framed provided each frame member of the assembly complies with the deflection requirements of **10.2**.

11 GLASS DIMENSIONS

11.1 The actual thickness for exterior and interior glass [other than DGU (Double Glazing Unit)] use shall be measured using screw caliper (for example as per **5.1** of IS 2835).

The actual thickness of glass, rounded to the nearest 0.1 mm shall not vary from the nominal thickness by more than the tolerances specified in respective Indian Standard or the values provided in this standard (unless Indian Standard specifications are developed).

The minimum thickness allowed in insulated glass unit (IGU) should be the sum of minimum thickness allowed of two panes as per IS 14900 plus thickness of air-gap.

The minimum thickness allowed in laminated glass should be the sum of minimum thickness allowed of two panes as per IS 14900 plus thickness of interlayer (*see* Table 5).

Table 5 Minimum Thickness for Laminated Glass

(*Clause* 11.1)

All dimensions in millimetres.

Thickness	6	8	10	12	16	20	24
Tolerance	± 0.6	± 0.6	± 0.6	± 0.6	± 1.2	± 1.2	± 1.2

11.2 Length and width are defined with reference to the direction of draw of the flat glass ribbon (*see* Fig. 3).

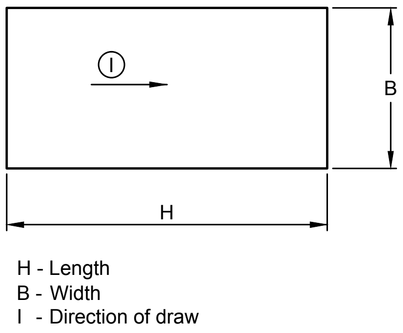


FIG. 3 REPRESENTATION OF LENGTH, WIDTH AND DIRECTION OF DRAW

11.3 Jumbo Sizes

Glass is available commonly in the following sizes of nominal length (*H*), 4 500 mm to 6 000 mm and nominal width (*B*), 3 660 mm or 3 210 mm.

NOTE — The usual width is 3 660 mm or 3 210 mm. Other sizes may be mutually as agreed to between the manufacturer and the user based on their requirement.

11.4 Stock Size

Glass is available commonly in the following sizes nominal length *(H*), 2 250 mm or 2 440 mm and nominal width (*B*), 3 660 mm or 3 210 mm.

NOTE — Maximum glass sizes available from manufacturer are one consideration, the processing equipment limitation, capabilities of contract fabricator to install unit, availability of specialized transport and handling equipment to deliver unit should be checked in addition.

11.5 Split Sizes

Glass is delivered in equal or unequal split sizes from the jumbo or stock size.

11.6 Squareness

The nominal dimensions for length (*H*), and width (*B*), be given, the pane shall not be larger than a prescribed rectangle resulting from the nominal dimensions increased by the permissible plus tolerance or smaller than a prescribed rectangle reduced by the permissible minus tolerance.

The sides of the prescribed rectangles (*see* Fig. 4) shall be parallel to one another and these rectangles shall have a common centre. For stock/standard sizes the tolerances on nominal dimensions length (*H*), and width (*B*), are ± 5 mm.

11.7 As-Cut Finished Size

The nominal dimension for width and length being given, the finished pane or as-cut finished size shall not be greater than the prescribed rectangle from the nominal dimension increased by the tolerance '*t*' or smaller than the prescribed rectangle reduced by the tolerance '*t*'. The sides of the prescribed rectangles are parallel to one another and these shall have a common centre in accordance to Fig. 5. The limits of the squareness are also mentioned. Tolerances are given in Table 6.

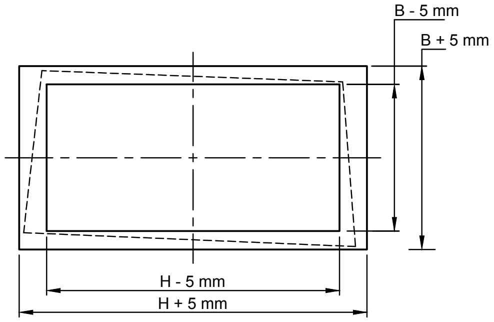


FIG. 4 DETERMINATION OF LENGTH, WIDTH AND SQUARENESS FOR STOCK/STANDARD SIZES

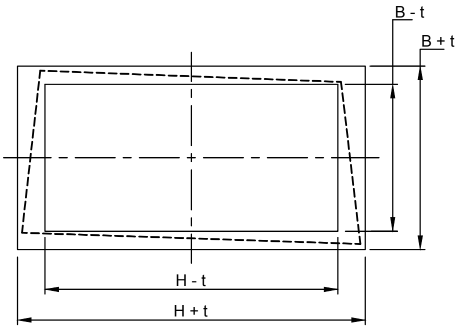


FIG. 5 TOLERANCE ON WIDTH (*B*) AND LENGTH (*H*)

Table 6 Tolerance on Width (*B*), and Length (*H*)

(*Clause* 11.7)

Sl No.	Nominal Dimension (*B* or *H*) mm	Tolerance '*t*'	
		Nominal Glass Thickness < 8 mm	Nominal Glass Thickness > 8 mm
(1)	(2)	(3)	(4)
i)	≤ 2 000	$^{+2}_{-0}$ mm	$^{+3}_{-0}$ mm
ii)	≤ 3 000	$^{+3}_{-0}$ mm	$^{+4}_{-0}$ mm
iii)	> 3 000	$^{+4}_{-0}$ mm	$^{+5}_{-0}$ mm

NOTE — While the above tolerances are generally applicable, with the advancements in manufacturing, the following suggested tolerance may be suitably decided between the concerned parties:

a) For glass of thickness up to 8 mm, tolerance shall be 1 mm per linear metre.

b) For glass of thickness above 8 mm and up to 16 mm, tolerance shall be 1.5 mm per linear metre.

c) For glass of thickness above 16 mm, tolerance shall be 2 mm per linear metre.

d) However, upper limit of tolerance shall be:

   1) ± 2.0 mm (for glass thickness ≤ 8 mm),
   2) ± 3.0 mm (for glass thickness ≤ 16 mm), and
   3) ± 5.0 mm (for glass thickness > 16 mm).

ANNEX A

(*Clause* 2)

LIST OF REFERRED INDIAN STANDARDS

IS No.	*Title*
419 : 1967	Putty for use on window frames — Specification (*first revision*)
543 : 2018	Cottonseed oil — Specification (*third revision*)
875 (Part 3) : 2015	Code of Practice for design loads (other than earthquake) for buildings and structures: Part 3 Wind loads (*third revision*)
1642 : 2013	Fire safety of buildings (general): Details of construction — Code of practice (*second revision*)
1950 : 1962	Code of practice for sound insulation of non-industrial buildings
2553 (Part 1) : 1990	Safety glass — Specification: Part 1 General purpose (*third revision*)
2835 : 1987	Flat transparent sheet glass — Specification (*third revision*)
5437 : 1994	Figured rolled and wired glass — Specification (*first revision*)
11433 (Part 1) : 1985	Specification for one part gun-grade polysulphide-based joints sealants: Part 1 General requirements
12118 (Part 1) : 1987	Two-part polysulphide based sealants — Specification: Part 1 General requirements
14900 : 2018	Specification for transparent float glass (*first revision*)
16231	Use of glass in building — Code of practice
(Part 2) : 2018	Energy and light (*first revision*)
(Part 3) : 2018	Fire and loading (*first revision*)
(Part 4) : 2018	Safety related to human impact (*first revision*)
16982 : 2018	Heat strengthened glass — Specification
SP 7 : 2016	National Building Code of India 2016

ANNEX B

(*Foreword*)

GLAZING IN BUILDINGS

B-0 All new glass construction shall be as per the provisions of IS 16231 (other than this annex). This annex is retained in this standard only to enable maintenance and servicing of glass construction which were designed and installed as per IS 3548.

B-1 TERMINOLOGY

The following definitions shall apply for this annex**.**

B-1.1 Anchor — A strip of metal bent to an ‘L’ shape. The longer leg has countersunk holes for screws to fix the anchor to the background, and the shorter leg supports the glass without protruding beyond the face.

B-1.2 Back Clearance — *See* **B-1.7** and Fig. 6.

B-1.3 Back Putty — The portion of putty remaining between the glass and the depth of the rebate after the glass has been pushed into position (*see* Fig. 6).

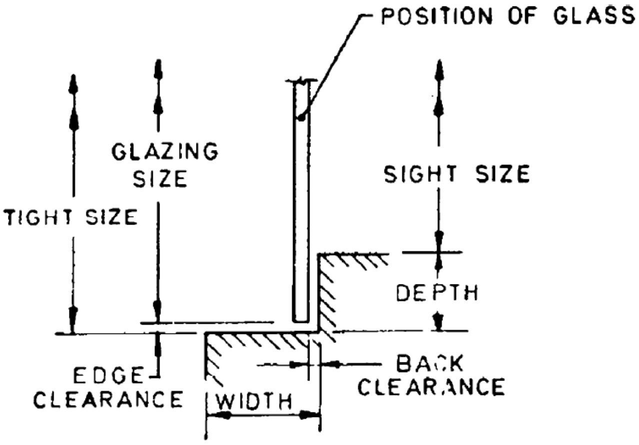
B-1.4 Bead or Glazing Bead — A strip of wood, metal or other suitable material attached to the rebate to retain the glass.

B-1.5 Bedding Putty — The compound placed in the rebate of the opening into which the glass is bedded.

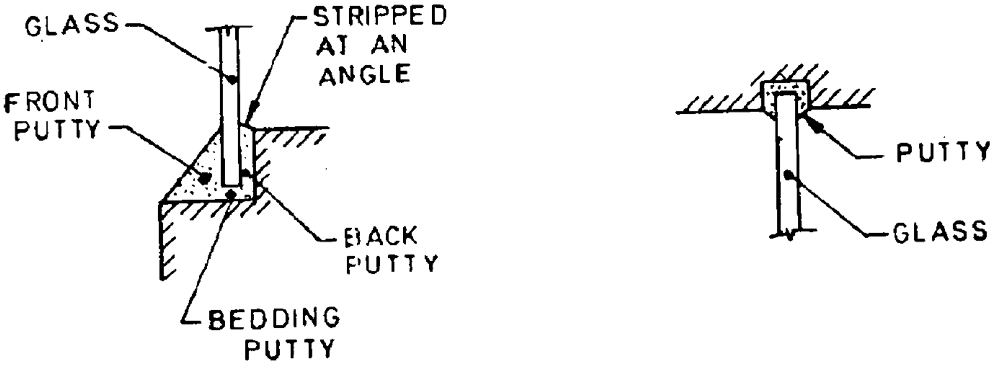
B-1.6 Block — A small piece of wood, lead or other suitable material used between the edge of the glass (generally the bottom edge only) to centralize the glass in the frame (frequently called a setting block).

B-1.7 Clearances — The edge clearance and back clearance are as shown in Fig. 6.

B-1.8 Distance Piece — A small piece of wood, lead or other suitable material used to locate the glass between the bead and the back of the rebate, and prevent lateral movement.



6A Glazing Rebate



6B Glazing with Compound

6 C Glazing into Groove

Fig. 6 Typical Illustrations Showing Glazing Details

B-1.9 Expansion Tape — *See* **B-1.18.**

B-1.10 Fixing Compound — A material used in fixing glass, applied by hand, knife or trowel, or as a pre-formed strip and capable of adhering to a wide variety of surfaces.

B-1.11 Frame — *See* **B-1.31**.

B-1.12 Front Putty — The compound forming a triangular fillet between the surface of the glass and the front edge of the rebate.

B-1.13 Glazing — The securing of glass in prepared openings, such as windows, door panels, screens and partitions.

B-1.13.1 *Double Glazing* — *See* **4.10**.

B-1.13.2 *External Glazing* — A glazing, either side of which is exposed outside the building (contrast with outside glazing).

B-1.13.3 *Louvered Glazing* (*Horizontal*) — A glazing with strips of glasses placed angular and one above the other at a distance sloping outside.

B-1.13.4 *Louvered Glazing* (*Vertical*) — A glazing with strips of glasses spaced vertically side by side at an angle.

B-1.13.5 *Multiple Glazing* — A form of glazing based on the same principle as double glazing, but incorporating three or more panes of glass.

B-1.14 Glazing Compound — A material used in glazing, applied by hand, gun, knife or trowel, to provide a bedding for the glass and weather-tight joint between glass and surround.

B-1.15 Inside Glazing — An external glazing in which the glass is inserted from inside the building.

B-1.16 Outside Glazing — An external glazing in which the glass is inserted from outside the building.

B-1.16.1 *Outside Face* — Keeping of the rough surface of textured or other glass outside while fixing the glass.

B-1.17 Internal Glazing — Glazing, neither side of which is exposed outside the building (contrast with inside glazing).

B-1.18 Insulating Strip — A strip of resilient material used to insulate the edge of the glass against rigid contact with non-resilient material (sometimes called expansion tape) .

B-1.19 Pane — A piece of glass cut to size and shape ready for glazing (often called a square).

B-1.19.1 *Louvered Pane* — A strip glass cut to the size of louver with smoothened edges ready for fixing.

B-1.20 Peg — A small metal component used in glazing to hold the glass in a metal frame (sometimes called spring).

B-1.21 Pointing Compound — A plastic non-setting compound having a workable consistency so that it may be handled and filled into joints readily.

B-1.22 Rebate — The part of a surround; the cross-section of which forms an angle into which the edge of the glass is received.

B-1.23 Saddle Bar — A metal stiffening bar, across the face of the glass and secured to the surround, to which a leaded light is tied.

B-1.24 Sash — *See* **B-1.31**.

B-1.25 Sealer — A liquid compound of brushing consistency applied to a surface to prevent the absorption of soils from the glazing or fixing compounds, or to prevent attack by alkalis on these oils.

B-1.26 Setting Block — *See* **B-1.6**.

B-1.27 Sizes

a) Daylight size : sight size
b) Full size : tight size
c) Glass size : glazing size

B-1.27.1 *Sight Size* (*Daylight Size*) — The actual size of the opening which admits light (*see* Fig. 6).

B-1.27.2 *Tight Size* (*Full Size, Rebate Size*) — The actual size of the rebate opening (*see* Fig. 6) (contrast with glazing size).

B-1.27.3 *Glazing Size* (*Glass Size*) — The actual size of a piece of glass cut for glazing (*see* Fig. 6).

B-1.28 Spring — A small headless nail or triangular piece of metal used, in addition to putty, for securing panes of glass in surrounds (*see also* **B-1.20**).

B-1.29 Spring Clip — A small metal component used, in addition to putty, for securing panes of glass in metal frames.

B-1.30 Square — *See* **B-1.19**.

B-1.31 Surround — Any frame, sash, casement or other building component into which glass is glazed.

B-2 NECESSARY INFORMATION

B-2.1 The following necessary information for efficient planning and distribution of the work shall be furnished by the general building contractor:

a) Type of glass to be used with details, such as colour, pattern and ornamentation; and
b) Details of the techniques to be employed in the work and other materials to be used.

B-2.2 The following information shall be given to the supplier when glass is ordered:

a) Type, quality thickness and substance of glass;

b) In specifying sizes, the first dimension given should be the height. Mode of measurements taken, that is, tight size, glass pane, size, etc, shall be mentioned. In case of extra allowance required for coloured glass, tight size with allowance required shall be indicated;

c) In specifying sizes of preparing templates for shaped glasses, the face side should be specified;

d) In specifying sizes for bevelled plates, decorated plates, factory made double glazing units, leaded lights, copper lights or louver ventilators, both tight and sight sizes should be given;

e) In all cases where patterned glass, decorated glass, leaded lights or copper lights are required to align, this should be specified and a dimensional sketch provided, if necessary;

f) In cases where wired glass is required to align one way between adjacent panes within the limits of manufacture, this should be specified; and

g) When ordering bent glass, the following additional items should be provided:

   1) *Bent one way only to curve or series of curves* — A rigid template cut to the exact curve and marked to indicate whether it represents the concave (hollow) or convex (round) side of the glass;

   2) *Bent one way of the pane only, the curve being arc of a circle* — A drawing showing straight edge, girth and radius of curve may be acceptable to the vendor in place of a template, provided it is marked to indicate whether it represents the concave (hollow) or the convex (round) side of the glass; and

   3) *Bent both ways of the pane, whether the curves are simple curves or not* — A rigid body mould shaped to the exact contour of the pane and marked to indicate which side of the glass it represents.

B-3 MATERIALS

B-3.1 Glass used for glazing in buildings should conform to following Indian Standards:

a) Sheet glass — *See* IS 2835;

b) Safety glass — *See* IS 2553 (Part 1); and

c) Wired and figured glass — *See* IS 5437.

B-3.2 Glazing compound for glazing should conform to following Indian Standards:

a) Putty : IS 419

b) Polysulphide based : IS 11433 (Part 1), and IS 12118 (Part 1) sealants

NOTES

1 *Compounds for glazing in concrete, stone, brick or asbestos cement* — These types of compound normally need to be sealed to prevent absorption of oil from the glazing compound, unless the compound has been specially formulated; resistance to alkali is generally important. A non-setting compound may be used, provided it is painted.

2 *Non-setting compounds* — These are needed for use with colour and heat-absorbing glasses which shall become hot in sunshine and which are, therefore, liable to expand and contract much more than ordinary glass. The fact that non-setting compounds are easily finger marked makes it undesirable to use them without beads, except in relatively inaccessible situations. If, in order to prolong its life, or for other reasons, the compound is required to take paint, reference should be made to the manufacturer of the compound.

B-4 DESIGN

B-4.1 Selection of Thickness of Glass

For vertical windows secured on four edges, the minimum thickness of glass shall be found as follows:

a) The maximum wind load average over a 1 min period or preferably 3 s period should be ascertained (*see* Note).

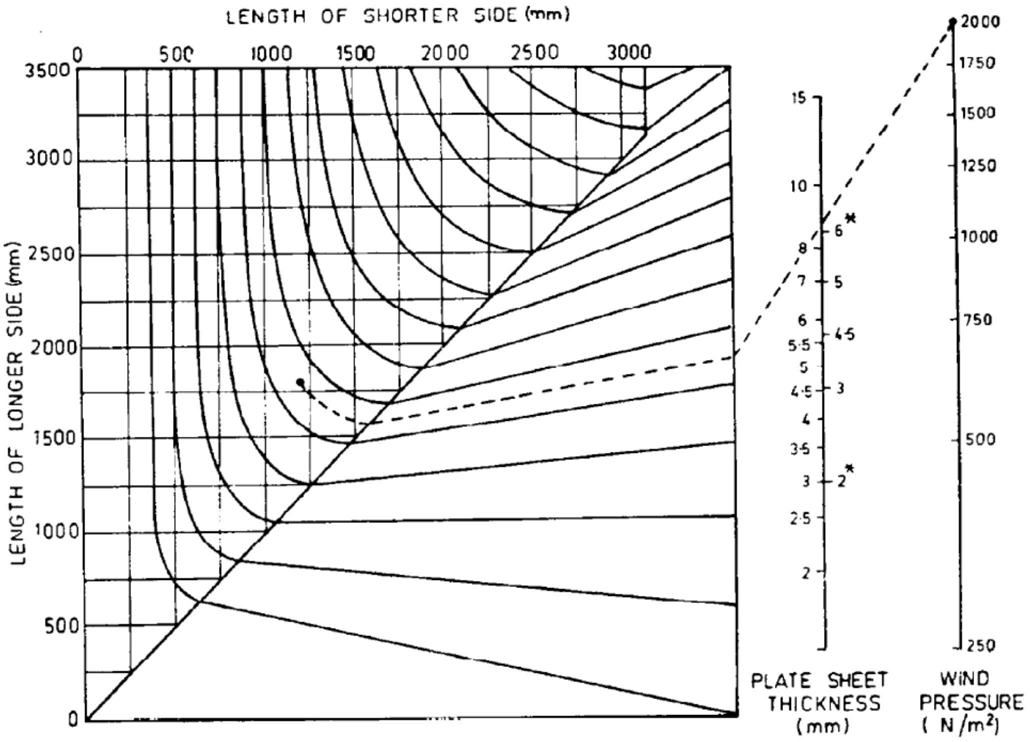
b) Allowance should be made for both inward and outward pressure and the maximum pressure as a result of combination of this fact shall be found; correction for relevant height of the building and also for shield effect of obstructions surrounding the buildings should be made in accordance with the principles laid down in IS 875 (Part 3).

c) The glass factor for the particular use should be found by dividing the area of the glass pane expressed in m^2 by the perimeter in running metres. For rectangular area, for instance, this would be $[\,(a \times b) / 2(a + b)\,]$, where a and b are the dimensions of the sides, in metre. The minimum thickness of glass corresponding to various wind loads shall be found from Fig. 7, knowing the design pressure and glass factor.

NOTE — Wind load data collected over a long period shall be available from the Meteorological Department and from this the maximum wind velocity and pressure corresponding to specific duration may be found. Unless very severe conditions of exposure warrant special considerations for design, the wind pressure data recommended in IS 875 (Part 3) (which correspond to measurement taken over a period of about 5 min) may be used in normal circumstances.

B-4.2 Durability

Though, under ordinary condition, glass has excellent durability, all glasses are subject to deterioration by action of water and prolonged attack by alkaline solutions may damage glass. If glass is allowed to remain dirty for a long period, the dirt film will tend to hold water and in this way, a process of surface attack may begin.



*Weight of glass in kg/m^2 approximately equal to 2.6 times the thickness in millimetres. Nomogram for determining thickness of window panes for various wind pressures. (Modulus of rupture of sheet glass taken as 38 N/mm^2 and of plate glass as 19 N/mm^2 after making allowance for variability of strength).

FIG. 7 NOMOGRAM FOR DETERMINING THICKNESS OF GLASS PLATE AND SHEET FOR WINDOW PANES

B-4.3 Fire Resistance

In regard to fire resistance requirements for glazing, reference may be made to IS 1642.

B-4.4 Thermal Expansion and Contraction

For heat absorbing glass and clear glass with painted surface especially where the colour is black and when ordinary glass is used under dark background, the following special protections are necessary to provide for thermal expansion and contraction, and temperature of the glass may be liable to large variations on exposure to sunshine:

a) Where the longer dimension is less than 750 mm, a glazing allowance of not less than 3 mm shall be given. Where the longer dimensions exceeds 750 mm, not less than 5 mm clearance all round shall be given;

b) The minimum cover necessary for safe glazing, except where toughened glass is used, shall not exceed 10 mm as otherwise there is risk of cracking owing to the shielded edge remaining colder than the exposed area; and

c) Glazing compound should be non-setting compound and all absorbent rebates and grooves should be treated with a sealer and not merely primed.

B-4.5 Light Transmission and Heat Insulation

For improved heat and sound insulation, double or multiple glazing may be used. The heat insulation depends upon spacing and scarcely at all on the thickness of the glass used. For vertical glazing, the insulating value increases up to a spacing of about 10 mm, beyond which there is little further change. However, the spacing of as little as 3 mm shall provide an insulating value of 50 percent of this maximum. For inclined or horizontal glazing, there may be some advantages in using spacing greater than 20 mm where this is practicable. However, while designing for heat insulation, it should be remembered that frame members of high thermal conductivity may provide direct paths for heat leakage between the inside and outside air and thus appreciably impair the insulating value of the installation as a whole. The values of different light transmittance and heat/light ratio is given in Table 7.

B-4.6 Sound Insulation

For sound insulation, reference may be made to IS 1950. For effective sound insulation, spacing of the order of 100 mm and above be adopted in case of double or multiple glazing. Thicker glass also provides insulation. Further improvements may be effected by lining the surrounds between the glasses with a sound absorbing material.

Table 7 Diffuse Light Transmittance and Heat Light Ratio of Glazing Materials

(*Clause* B-4.5)

Sl No.	Material	Thickness mm	Diffuse Light Transmittance	Heat/Light Ratio
(1)	(2)	(3)	(4)	(5)
i)	Clear glass	3.0	0.85	0.86
ii)	Double glazing (clear glass)	3.0 each	0.72	0.74[1)]
iii)	Heat absorbing glass	3.2-3.5	0.62	0.24
iv)	Figured glass	3.2	0.78	0.83
v)	Wire-cast glass	6.0	0.67	0.71

[1)] Double glazing reduces heat/light ratio. Further, the heat insulation of double glazing also improves due to air gap casing reduction of the overall heat transmission coefficient.

B-4.7 Rebates and Grooves

These should be rigid and true. Rebates for normal glazing shall be at least 8 mm deep, for small panes rebate may be 6 mm deep. For large windows, such as shop windows, the frame rebates at the tops and sides should be at least 10 mm and at the bottom 12 mm. Rebates for double or multiple glazed sealed units shall be 16 mm deep generally, unless otherwise advised by the manufacturers of the particular units. Rebates for flat glass without beads should be wide enough to accommodate the back putty, the glass and the front putty stripped at an angle. A wider rebate is needed for bent glass than for flat glass. For glazing with beads, rebates should be wide enough to accommodate glass and beads and to allow a minimum clearance of 1.5 mm at both the back and front of the glass. Rebate and grooves shall be clean and unobstructed before glazing.

B-5 GLAZING

B-5.1 Size for Glass

The size of glass for glazing shall allow a clearance between the edge of glass and surround as specified below:

a) For wood or metal surrounds : 2.5 mm; and
b) For stone concrete or brick : 3.0 mm

The clearance may be increased, provided the depth of the rebate or groove is sufficient to provide not less than 1.5 mm cover to the glass.

B-5.2 Location of Glass in Frame

The glass shall rest upon two blocks to locate the pane properly within the surround. In the case of small panes, use of blocks may not be necessary. When glazing in side-hung windows or doors, the glass shall be located by blocks so that it bears on the bottom of the surround at a point near the hinge, but is not brought into contact with the surround and does not suffer undue stress.

B-5.2.1 When glazing in horizontal centre-hung sashes, which may be turned through about 180°, additional blocks shall be placed between the top edge of the glass and the surround to prevent movement of the glass when the sash is inverted, Where the panes are more than 90 mm high, the glass shall be located at the two pivoting points by blocks of suitably resilient material, such as chloroprene.

B-5.3 Preparation of Rebates and Grooves in Wood

Rebates or grooves should be primed to prevent excessive absorption of oil from the putty. If a shellac varnish or gloss paint is used for this purpose, the wood may be completely sealed and setting of the putty unduly delayed.

B-5.3.1 Absorbent hardwood frames that are not to be painted should either be primed with a medium composed of equal parts of exterior varnish and white spirit, and glazed with linseed oil putty or be completely sealed with a coat of untinned exterior quality varnish and glazed with metal casement putty (which will need to be painted), or with a non-setting compound. Where hardwoods such as teak which are completely non-absorbent are recommended metal casement putty should be used. If the wooden frame has been treated with a preservative, according to the instructions of the manufacturer of the glazing compound, preparation of rebates and grooves should be made.

B-5.3.2 In the case of stone, concrete, brick or other similar materials, the rebates of grooves should be sealed with an alkali-resisting sealer and allowed to dry before glazing. The compound shall be metal-casement putty.

B-5.4 Glazing with Compound

This method is suitable for window and door panes where the combined height and width do not exceed the maximum shown in Fig. 6 for appropriate exposure grading.

B-5.5 Glazing with Beads

This method should be used for window and door panes where the combined height and width exceed the maximum shown in Fig. 6 for glazing in unpainted hardwood frames and framed shop fronts for double and multiple glazing units as defined in **B-5.9** (d), and wherever a non-setting compound is used in a position where it is liable to be disturbed.

B-5.6 Glazing with Compound into Rebates

Sufficient compound should be applied to the rebate so that, when the glass has been pressed into the rebate, a bed of compound (known as back putty) not less than 1.5 mm thick will remain between the glass and the rebate; there should also be surplus of compound squeezed out above the rebate which should be stripped at an angle (*see* Fig. 6) not undercut, to prevent water accumulating. The glass should be secured by springs or spring clips spaced not more than 450 mm apart measured around the perimeter of the pane, and afterwards fronted with compound to form a triangular fillet stopping 1.5 mm short of the sight line so that the edge of the compound may be sealed against the glass by painting, without encroaching over the sight line.

B-5.7 Glazing with Compound into Grooves

The glass should be pressed into glazing compounds previously placed in the groove. The spaces between the glass and the sides of the groove should be filled with compound, which should then be stripped at an angle (*see* Fig. 6) not undercut.

B-5.8 Glazing with Beads Along with Compound

Sufficient compound should be applied to the rebate so that when the glass has been pressed into the rebate, a bed of compound (known as back putty) not less than 1.5 mm thick will remain between the glass and the rebate. There should also be a surplus of compound squeezed out above the rebate which should be stripped at an angle not undercut, to prevent water accumulating. Beads should be bedded with compound against the glass and wood beads should also be bedded against the rebate.

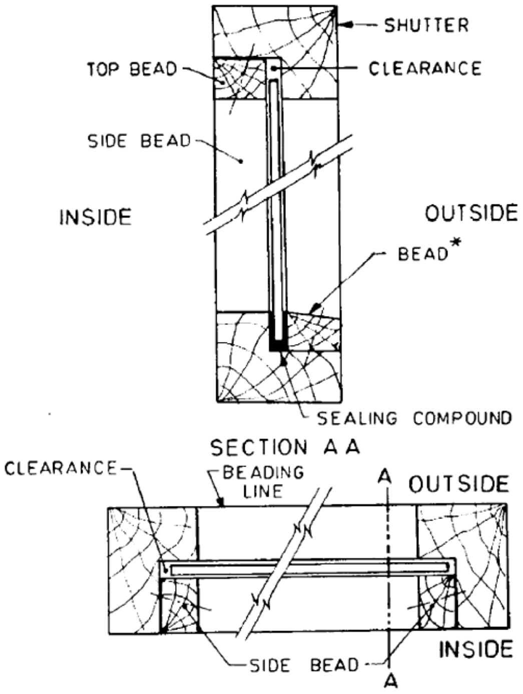
B-5.8.1 Care should be taken to ensure that no voids are left between the glass and the bead. For outside glazing, hollow beads are undesirable unless they can be completely filled.

B-5.8.2 With non-setting compound and where there is a risk of glazing compound being dislodged by pressure, front and back-distance pieces (to maintain face clearances) should be used. Distance pieces should be completely embedded in the compound.

B-5.8.3 Beads should be secured to wooden frames with either panel pins or screws and to, metal frames in the way provided for in the frame. In securing to wooden frames, an adequate number of fixing for the beads should be used so as to prevent flexing or movement of the beads.

B-5.8.4 The external glazing should be as far as possible fixed from outside with beads as stated in **B-5.8**.

B-5.8.5 Where it is not possible to fix the class from outside, especially in a multi-storeyed building, it may be fixed from inside with sealing compound as shown in Fig. 8.



*Can be fixed prior to or after placing the glass pane as per site conditions.

FIG. 8 INSIDE GLAZING

B-5.8.6 Figured glasses are used to avoid direct sunrays and to get diffused light. This can be achieved advantageously by placing rough surface of the glass facing outside. As the surface of glass from inside is smooth, it will facilitate in pasting of colour plastic film on inside surface, whenever required. In that case, it will be difficult to clean the rough surface of glass which is outside but it can be cleaned by a water jet.

B-5.9 Double and Multiple Glazing

The problems connected with the application of double and multiple glazing are briefly as follows:

a) *Two separate window frames, each single glazed* — These are preferable for sound insulation. To avoid problems of dirt and moisture in the air space, means of access to the cavity should be provided.

b) *One window frame carrying two sashes coupled together, each separately glazed* — The glazing may be in separate rebates, one inside-glazed and the other outside glazed, or in single, wide rebates with spacing beads. The former method has the advantage that either pane can be replaced without disturbing the other. However, carefully such glazing is done, it may be necessary to open the cavity at frequent intervals for the purpose of cleaning.

c) *One window frame of sash single-glazed provided with clip to permit the attachment of a second glass* — This system involves no serious cleaning problems since the clipped on panes can be quickly detached. Their main use is on existing windows which cannot otherwise be modified.

d) *Double or multiple factory-made hermetically sealed units* — Problems of cleaning of inner surfaces does not arise. Adequate rebate shall be provided in accordance with manufacturer's instruction.

B-5.10 Double Glazing Other than Factory Made Sealed Units

To minimize entry of warm moist air from the interior of the building or penetration of rain from outside into the cavity, the glazing should be done in a careful and thorough manner. Where opening sashes are provided, it is essential that they should fit closely. A small breathing hole or tube should be provided from the bottom of the cavity to the outside to ensure that such breathing vents are kept clear of paint or other obstructions,

B-5.10.1 Where separate panes are glazed in one sash, it is preferable to use preformed strip of compound for the back putty in glazing the second pane, in order to provide full back putty with a neat finish. Usually it is better to glaze the outer pane first.

B-5.11 Factory-made Double or Multiple Sealed Units

When ordering factory-made double or multiple sealed units, the following points may be taken into account:

a) Both tight size and sight size (not glazing size) should be specified;

b) Sealed units should be checked in the opening for edge clearance consistent with the manufacturer's recommendations. It is essential to follow any recommendations given by the manufacturer concerning the correct edge to be glazed at the bottom. Units should be positioned in the compound approximately one quarter of the total length from each end. The width of the blocks should be not less than the thickness of the sealed units and their thickness should be such as to position the units centrally in the opening. This thickness of glazing compound between the glass and the back of the rebate, and between the glass and the bead should be about 1 mm;

c) Special techniques of glazing are required to protect the seal and reference should be made to the manufacturer of the glazing units;

d) A non-setting glazing compound having good adhesion to glass and frame should be used. All absorbent rebates and beads should be treated with a sealer (priming is not sufficient);

e) Glazing with beads should always be used. Hollow beads are not recommended; and

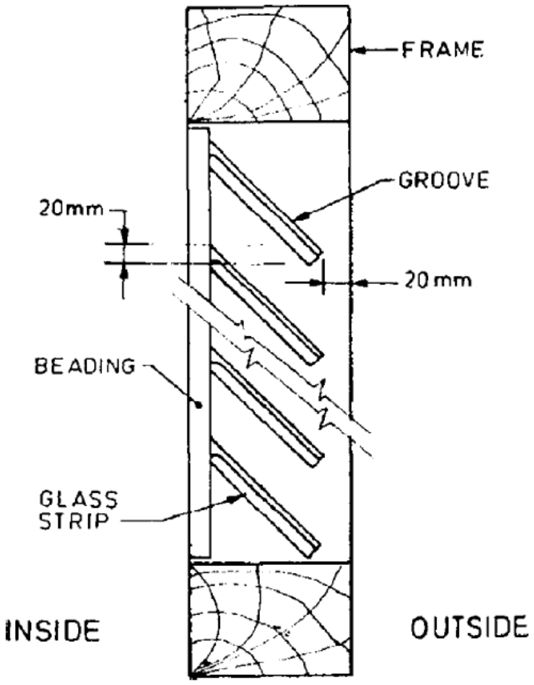
f) Where there is a risk of the glazing being dislodged by pressure, front and back distance pieces should be used to maintain face clearance.

B-5.12 Louvered Glazing

This type of fixed glass louvers are recommended for toilets, stores, etc, where permanent ventilation is required.

B-5.12.1 *Louvered Glazing (Horizontal)*

Glass strips with rounded edges are inserted from inside in the grooves placed one above the other. The grooves shall be angular preferably at 45° on the frame. The grooves shall overlap over each other by at, least 20 mm as shown in Fig. 9.



NOTE — The depth of groove may be thrice the thickness of glass and width of the groove may be 1 to 1.5 mm more than the maximum thickness of glass.

FIG. 9 FIXED GLAZED LOUVERED WINDOW

B-5.12.2 *Louvered Glass* (*Vertical*)

Glass strips are placed angularly and vertically, and inserted as described in **B-5.12.1**.

B-5.13 Maintenance

B-5.13.1 *Cleaning*

Glass should be cleaned regularly. Failure to do this shall result in considerable reduction of daylight indoors, and may also result in discolouration and deterioration of the surface. Warm water with soap or a mild domestic detergent, followed by a clean water rinse is generally adequate for routine cleaning. For transparent glasses, cloth or wash leather should be used; for glasses with a broken or textured surface, a stiff plastic or bristle brush will be found effective. Where the above methods fail to remove obstinate dirt from transparent glass, polishing with whiting in water or methylate spirits may be found to be successful. Corrosive cleaning liquids are also sometimes employed, but should be handled with great care and should be sluiced away with excess of clean water as soon as possible after use to avoid damage to glazing or fixing compounds, window frames or any other materials near to the glass. Organic solvents are also useful for special purposes, for example, petrol or benzene for removing tar, turpentine for paint that has not dried hard and paraffin for grease. The solvents should, however, be carefully cleaned off the glass afterwards and, in some instances, the fire risk may need to be guarded against during use. Plaster or mortar splashed on the glass may be removed with a thin razor blade preferably before the material has set hard. Dried paint may be removed similarly. In using the razor blade, excessive force should not be used.

B-5.13.1.1 If a trial shows that none of the above methods is likely to be quickly successful, it may be more economical to replace the glass.

B-5.13.1.2 Where the cleaning of embossed, sand blasted or decorated glasses has been neglected, ordinary window cleaning methods may not be expected to be successful and treatment by a specialist is required.

B-5.13.2 *Replacement*

If wired glass is broken and allowed to remain exposed to weather conditions, moisture will penetrate to the wire which will rust. This will result in failure of the wire, which may allow the glass to fall. It is, therefore, essential that any breakage be made waterproof at once with a material such as a bituminous paint and replacement undertaken with new glass as soon as is practical.

B-5.13.3 *Maintenance of Glazing*

Glazing compound shall be regularly painted except where special materials are used. The building maintenance shall ensure that the metal work surrounding the frame do not corrode resulting in closing of gaps between the frame and glass or warping of timber with consequent breakage of glass.

ANNEX C

COMMITTEE COMPOSITION

Building Construction Practices Sectional Committee, CED 13

Organization	*Representative(s)*
In Personal Capacity (*Flat No. 2061, Engineers Apartments, Plot 11, Sector - 18A, Dwarka, New Delhi* 110078)	Shri D. S. Sachdev (***Chairman***)
Ahluwalia Contracts (India) Limited, New Delhi	Shri Shobhit Uppal Shri Pradeep Kumar (*Alternate*)
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Builders Association of India, New Delhi	Shri Surojit Samanta Shri Ram Avtar (*Alternate*)
Building Materials & Technology Promotion Council, New Delhi	Shri Chandi Nath Jha
Central Insecticides Board, Faridabad	Additional PPA cum Secretary (CIB & RC) Joint Director (Entomology) (*Alternate*)
Central Public Works Department, New Delhi	Chief Engineer (CSQ) Superintending Engineer (TAS) (*Alternate*)
Confederation of Construction Products and Services, New Delhi	Shri Deepak Gahlowt Shri Shashi Kant (*Alternate*)
CSIR-Central Building Research Institute, Roorkee	Shri S. K. Negi Dr Ajay Chourasia (*Alternate*)
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CSIR-Structural Engineering Research Centre, Chennai	Director Dr P. Srinivasan (*Alternate*)
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Indian Pest Control Association, New Delhi	Vice President General Secretary (*Alternate*)
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The Energy and Resources Institute, New Delhi	Shri Sanjay Seth Ms Megha Behal (*Alternate*)
The Indian Institute of Architects, Mumbai	Shri Vijay Garg Shri Shamit Manchanda (*Alternate*)
The Institution of Engineers (India), Kolkata	Shri P. K. Adlakha Shri Devendra Gill (*Alternate*)
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Glazing Society of India, Chennai	Shri Gohul Deepak Shri Subin Calvin Geo (*Alternate*)
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NTPC Ltd, New Delhi	Shri Anil Kapoor
Saint-Gobain Glass India Ltd, Chennai	Shri A. R. Unnikrishnan Shri N. Murali (*Alternate*)

Organization	*Representative(s)*
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The Energy Resources Institute, New Delhi	SHRI SANJAY SETH
The Indian Institute of Architects, Mumbai	SHRI VIJAY GARG SHRI ASHUTOSH AGARWAL (*Alternate*)
The Institution of Engineers (India), New Delhi	SHRI P. K. ADLAKHA

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